Decisions for Irrigation with Climate Fluctuations

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Battelle Pacific Northwest Division
PI: Michael J. Scott

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Abstract

Using a case study of the Yakima River Valley in Washington State, previous work has shown that relatively simple tools can be used to predict the impact of the El Niño phenomenon on water supplies to irrigated agriculture, that this information could be used to estimate the significantly shifted probability distribution of water shortages in irrigated agriculture during El Niño episodes, and that these shifted probabilities can be used to estimate the value of exchanges of water between crops to relieve some of the adverse consequences of such shortages under western water law. The current project will refine the process for conveying El Niño-Southern Oscillation (ENSO) forecasts for advanced planning of river management and irrigation seasons. We are applying lessons learned by ourselves and by others in the NOAA HDGCR program on successfully using climate information to assist practical management of resources. In a series of workshops, we will work with the Bureau of Reclamation Upper Columbia Basin Office (also called the Yakima Project Office: hereafter, Reclamation), irrigators, climate experts, the Washington State Department of Ecology (which manages the issuing and transfer of water permits), and other stakeholders to improve planning for drought conditions in the basin. The project also will experiment with web-based and in-person methods (workshops) to better manage and make more useful the dissemination of climate forecast information in predicting and managing water resources.

Using a reservoir model and probabilistic unregulated flow forecasts that vary by ENSO state, we will derive pro forma state-dependent rule curves for reservoir operations that satisfy flood control, irrigation water availability (including crop production economics) and instream flow objectives. Modifying rule curves according to ENSO/PDO state is expected to reduce the risk to junior irrigation interests facing specific levels of water prorationing. We plan to hold a series of intensive hands-on workshops with Yakima River basin stakeholders based on the principles of the convergence and collaborative learning approach for the purpose of information exchange and training in climate-variability-sensitive water management and revealing participants' information preferences and use. Workshop participants will be asked to develop and explain competing plans for coping with the climate forecasts, using the modeling tools. We will collect data on the role of information in the planning and response process in the workshops, with probes based on the key issues identified in the literature concerning the use of scientific information and analysis in policy making and individual decision making

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Project Funds Received at Battelle: 08/04/2003

Progress During 2004:

We have now held three of the four stakeholder workshops to be conducted under this grant at Heritage University (formerly, Heritage College) campus in Toppenish, WA. Late receipt of project funds and resulting late actual project start altered the first year schedule, but we have now recovered the time lost during the first year. The workshops were scheduled during the winter and early spring when a comparative lull in farm field work makes attendance at workshops easier for water managers and irrigators

Task 1. Modeling Lessons for Reservoir Operations /In-Stream Flows

We currently use a reservoir model and operating rule curves that satisfy flood control, irrigation water availability (including crop production economics) and instream flow objectives to converting these unregulated flows into goal-satisfying regulated flows in a probabilistic framework. Modifying rule curves according to ENSO/PDO state is expected to reduce the risk to junior irrigation interests facing specific levels of water prorationing.

Progress: We have two versions of the reservoir model for examining scenarios for the operating rule curves, both for the historical time period and a warmer climate typical of El Nino years. One version of the model conducts analysis using an ensemble of fifty synthetic water years based on historical and projected daily and monthly temperature, precipitation, and runoff to regulated and unregulated portions of the Yakima basin. The second version is much simpler, and is used to demonstrate the impact of specific individual historical analog water years (with and without additional climate warming) on feasible operating rules for the Yakima. We have found that the use of analog water years is an important teaching device, since farmers and water managers carry specific years in their memories as important behavioral clues. The current general operating rule being investigated follows the Bureau of Reclamation procedure of using the accumulated snowpack and typical climate years to forecast the water available for irrigation. The current method appears to be very conservative, by design—it forecasts more serious drought than actually occurs, but water managers prefer this outcome to one in which they are surprised by drought during an irrigation season. Resampling the historical record of reconstructed streamflows is being used as a technique to develop adequate sample sizes for analysis of different climate stakes.

It is clear from the three workshops and written material we have collected from other sources that a permanent water exchange mechanism is well on its way to being fully established in the Yakima basin. Although the participants were not directly influenced by us, this mechanism is developing along the lines suggested in Scott et al. (2004), with third-party consequences of potential trades being worked out in advance of need.

We have used our models to examine additional in-basin and out-of-basin storage and reduced water use (both improved efficiency in conveyance and reduced on-farm consumptive use) as potential methods. It appears that the largest storage project being discussed for the system (1.7 million acre feet) has the capacity to offset the impacts of the worst droughts on record and future climate warming-related drought. The benefits of such a project, if the water were available from the Columbia River under climate change, appear to pay for costs of the project under with future climate, but not under current climate. This result obtains because the probability of lower snowpack and serious growing season drought shifts dramatically with even relatively modest warming. Several institutional issues would be related to inter-basin water transfers have been identified. Investigation continues on whether the project would be cost-effective in comparison with, say, crop-switching.

The reservoir model also has been exercised with increases in in-basin additional storage. The additional storage significantly reduces the average number of days during which water must be prorated, but only in the years when carryover storage or high winter flow are important. Reducing water demand has an even larger impact.

Initial results have been presented to a number of professional and lay audiences, and peer-reviewed journal articles are in preparation.

Task 2. Modeling Detailed Lessons for Farms and Water Management Operations

A series of four intensive hands-on workshops (2 per year) were planned for information exchange and training in climate-variability-sensitive water management. In preparation for the workshops, selected project personnel underwent Human Subjects Research training, as mandated by our Internal Review Board and developing and vetting workshop materials.

An important outcome of the workshops is expected to be guidance to Bureau of Reclamation, Washington Department of Ecology, irrigation districts, and farmers on how to use NOAA forecasts to help manage drought. Holding the workshops over two years allows the Battelle team to provide ongoing feedback to the stakeholders on technical issues as well as to begin to develop institutions to more successfully manage the consequences of climate variability in the basin.

<u>Progress:</u> We have now conducted three workshops with the water management and user interests in the Yakima basin. Attachment 2 contains a summary of raw results from these workshops. We found that the participants, especially the water managers and some of the more sophisticated growers were well aware of NOAA seasonal forecasts and have become increasingly aware of the loss of snowpack projected under climate warming scenarios for the Pacific Northwest. Some of this awareness has come as result of outreach efforts by the University of Washington Climate Impacts Group to the water management community in particular. However, all of the decision-makers are significantly constrained by the legal need to follow the Bureau of Reclamation's annual projections of Total Water Supply Available (TWSA), which is only marginally influenced by NOAA seasonal climate forecasts.

While Bureau of Reclamation continues to investigate the risks of using the results from the NOAA seasonal climate forecasts to condition their forecasts of TWSA, workshop participants have pointed out the utility of using the NOAA seasonal forecasts to guide operational decisions not necessarily constrained by TWSA, such as fall-winter flow "shaping" for salmon migration and scheduling annual maintenance of irrigation works.

In preparation is a journal article that will discuss the workshop findings. Also scheduled is a presentation at a session of the 2005 American Association for the Advancement of Science on using lessons from dealing with climate variability to adapt to climate change.

Attachment 1. List of Publications and Presentations During 2004

Scott, M.J., L.W. Vail, C.O. Stöckle, A. Kemanian. 2004. "Climate Change and Adaptation in Irrigated Agriculture–A Case Study of the Yakima River." In Proceedings of the UCOWR/NIWR Annual Conference, July 20-22, 2004, Portland, Oregon. PNWD-SA-6448. Pacific Northwest National Laboratory, Richland, WA.

Scott, M.J., L. Vail, R. Prasad, and J. Jaksch 2004. Can We Use Long-Lead Climate Forecasts to Operate the Pacific Northwest Rivers Better? PNWD-SA-6512. Pacific Northwest Regional Economic Conference, Tacoma, Washington, May 19, 2004.

Scott, M.J. 2004. Impacts of Climate Change in Pacific Northwest Agriculture. PNWD-SA-6499. Transportation and Climate Change Conference 2004, Seattle, Washington, May 18, 2004

Scott, M.J., L.W. Vail, J.A. Jaksch, C.O. Stöckle, A. R. Kemanian. 2004. Water Exchanges: Tools to Beat El Niño Climate Variability. Journal of the American Water Resources Association 40 (1):15-31.

Scheduled

1. Scott, Michael J., Lance W. Vail, Claudio Stöckle, Armen Kemanian, Kristi M. Branch Rajiv Prasad, Mark A. Wigmosta, John A Jaksch. 2005. Adapting Irrigated Agriculture to Climate Variability and Change. PNWD-SA-6743. Presented at 2005 AAAS Annual Meeting, American Association for the Advancement of Science, February 20, 2005, Washington D.C.

Abstract: Assessment tools originally developed to project the impact of the El Niño phenomenon on water supplies to irrigated agriculture in Western U.S. river basins also can be used to estimate impacts during climate change. A single basin (the Yakima River in Washington State) is used as an example. Calculations for seasonal irrigation water have been done for a number of future climate scenarios. One apparently robust result is that reduced snowpack under climate warming will substantially reduce water available for agriculture, leading to legally mandated restrictions of water deliveries to holders of junior water rights. The significantly shifted probability distribution of water shortages in irrigated agriculture during climate change can be used to estimate the impact on agriculture. The more permanent nature of changes in the temperature and precipitation regime associated with climate change means that risk management options also take a more permanent form (such as changes in crops and cultivars, and adding storage). "Soft" solutions such as temporary water trading are applicable to current drought events, but more permanent transfers likely would be needed for future warmer conditions. Institutions strongly control the scope of both temporary and longer term water markets. With more certain future drought, preliminary analysis suggests that additional in-basin storage may become much more economically attractive. The same tools may also prove valuable in screening options for other river basins.

2. Scott, Michael J., Lance W. Vail, Claudio Stöckle, Armen Kemanian, Kristi M. Branch Rajiv Prasad, Mark A. Wigmosta, John A Jaksch. "Benefits and Costs of Options to Mitigate the Uncertain Effects of Climate Change on Irrigated Agriculture in the Yakima Basin. What Matters? What Doesn't?" Pacific Northwest Regional Economic Conference, Bellingham, Washington, May 20, 2005.

Abstract: Assessment tools originally developed to project the impact of the El Niño phenomenon on water supplies to irrigated agriculture in Western U.S. river basins also can be used to estimate impacts during climate change, which may already be occurring. In the Yakima Basin, future water supplies are highly uncertain, but future climate warming is expected to dramatically increase the probability of summertime drought-like conditions, while simultaneously increasing the probability of winter flooding The presentation describes the application of hydrologic and economic tools to evaluate the changed circumstances and management strategies under climate change. A number of strategies are considered and evaluated, including increased in-basin and out-of-basin storage, water trading, and crop switching

Attachment 2. Sample Raw Workshop Results

Workshop 1: <u>Questions on Long-Range Weather Forecasting for Water Managers</u>

1. How familiar are you with:

- the National Oceanic and Atmospheric Administration (NOAA) seasonal weather forecasts
- the Bureau of Reclamation (BuRec) Water Availability forecasts of Total Water Supply Available (TWSA)?
- the River Forecast Center/ NRCS water equivalent (estimate of existing snowpack) data?

	Forecast		
Degree of Familiarity	NOAA Seasonal Climate Forecasts	Total Water Supply Available	River Forecast Center/NRCS
Very Familiar	3	7	6
Somewhat Familiar	4	0	3
Not Familiar	0	0	0
Abstain (No Vote)	2	2	0

2. Do you use the NOAA seasonal forecasts in your work? Do you use **long-term** weather forecasts in your work? If yes, how? If not, why not?

- TWSA from Bureau of Reclamation is the main forecast used by the group. The other forecasts are looked at and correlated with each other and the main methodology.
- NOAA long lead forecasts are used to condition the TWSA forecast. They are looked at particularly in the fall and winter.
- They mostly pay attention to whether the climate state is El Nino or not
- They are generally conservative in the winter: “move only the water you have.” They are willing to take a few more risks on the front end of winter.
- Their runoff forecast is compared to the National Weather Service Forecast. The runoff forecast goes directly to TWSA. National Weather Service forecast is used to evaluate the runoff forecast.

- Definition of “risk-taking.” The amount of water used for fish flows is based both on the amount of water available and climate conditions.
- To be useful, the effects of El Nino must be specific to the basin-there are subtle differences between years that are not captured well by a large-scale forecast 6 months ahead.
- They base their decisions on their specified models/procedures, which give them relatively little latitude and limited ability to utilize insights reflected in probabilities.
- To a significant degree, they compare existing conditions (and base expectations and descriptions of forecasts) with historical “years.” I.e., trying to determine whether this year will be more like 19XX or 19YY. [As a result of this answer, we have developed an Excel-based “toy” simulation model that allows water users to evaluate the consequences of estimating the degree of water rationing that will be necessary for any of 50 historical water years, with and without climate change.]

3. What information do you use to determine whether we are experiencing drought?

There two ways in which “drought” happens in the Yakima, with different institutional conditions

- The state declares drought. This allows a number of emergency procedures (water trading, use of emergency wells) to be used to reduce the impact.
- TWSA is low enough that prorationed water supplies are below 80%. This in itself does not allow emergency measures to be taken.

Climate forecasts cannot influence either one of these directly. Climate (water) forecasts if available in the July-October period could be used to decide the amount of water to allocate to fish in the fall and winter. These decisions are made in August, but could be modified later. Improvements could reduce the amount of “flip-flop” between the northern storage projects (Yakima main stem) and southern storage projects (Tieton) used in the system. Early enough information in the spring might help plan for the irrigation season. A particularly valuable piece of information would be early warning of back-to-back droughts, since projects that have not been filled cannot be drafted in the summer to make up for short snowpack.

5. Do you use forecasts of Total Water Supply Available? If not, why not? If so, how?

- Answered above

6. If NOAA could provide perfect weather forecasts for the coming water year, what difference would that make to any water management decisions that you make? Does it make any difference when the forecast is available? E.g., would you change anything if the perfect forecast were available in March? January? October?

- Ninety day [1/3,1/3,1/3} forecasts with slight shift in odds [say, 40-30-30] probably cannot be used for significant decisions like TWSA and prorationing
- Might be able to use such forecasts where the institutional downside risk of being wrong is not as great, say in water banking or "shaping" water flows for fish.

A quantitative note on shaping water for fish and winter operations, an activity that occurs in the fall before winter precipitation, reservoir levels, and snowpack are known. The difference of 200 cfs for 100 days or so is 40,000 ac-ft on a base of 2.9 million ac-ft annual flow. It's about 4-5% of proratable demand. The project usually delivers about 70% of demanded water even in the worst years. So we are not talking about a lot of water for instream flow and protection of migrating salmon (about 300 cfs), and this is now being recognized by irrigation interests.

For planning purposes, they have been using observed data on water in reservoirs and estimated in snowpack beginning in January, and use forecasts only for weather for the remainder of the water year.

The first principle is that TWSA runs the basin. It is essential to use TWSA to get local buy-in. However, it may be possible to use forecasts to improve the inputs to the TWSA, provide perspective by showing whether a current operating year may be similar to other water years, and provide improved confidence in the forecasts of flow.

Other possible uses for the forecasts:

- Improved estimates of flood risk
- Estimating water availability for fish management
- Construction and maintenance schedule (e.g. don't schedule dam maintenance in years that you will likely need all of the water storage available
- May provide some assistance in crop choice in years where water may be available/not available (decision drop-dead points. Being developed crop-by-crop.)
- Project operations
- Irrigation (scheduling?)
- Recreation planning (recreation is incidental)

Note on demands for water in the system: there is a problem of changed expectations in the newer landowners. They forgot (or never knew) the conditions under which the junior districts such as the Roza were developed. They do not understand the patterns of water availability and the limitations on their water rights. The participants considered this a significant issue that needed attention/action.

7. What if perfect water availability forecasts were available? E.g., would you change any decision if the perfect water availability forecast were available in March? January? October? How much would a perfect seasonal forecast of water supply (rather than climate) help? When would it be needed?

- For storage control, a perfect forecast would help if available by July 1 (at the latest, in August) for the coming water year
- For water banking and planting of fall crops, a perfect forecast would help in late summer
- For sharing irrigation and fish risks, perfect forecast would help in the September-October time frame
- For (winter flow) water shaping for fish, perfect forecast would help in September or early October. However the degree of certainty is more important here than timing.
- For crops other than those planted in the fall, perfect forecast would help in January or February

Note: a 70% confident idea of forecast conditions would still be an improvement.

Does perfect <u>weather</u> (not water) information help?

- Information on when to expect snowmelt above and below reservoirs would help water management.
- Runoff model used by BuRec could use good analog climate years

8. NOAA climate forecasts and BuRec TWSA forecasts are somewhat uncertain. How does this affect your use of the forecasts and why?

- They monitor actual snowpack and reservoir conditions and produce a forecast of TWSA that includes plus-or-minus 50 percent intervals for projected precipitation. This projection is currently based on analog water years. From the historical record.

9. What is the single hardest thing to "get right" in your water management decisions? When do these decisions happen? What happens if you are wrong? Would a "better" weather or water forecast help? If so, what would such a "better forecast" look like and how would it make your decisions better?

- Being wrong on a TWSA forecast for short water is institutionally challenging, since it has legal repercussions. If they believe they will be water-short and hold back water, they need buy-in from the irrigators. Running out of water (forecast more than shows up) is bad luck; failing to release water that they actually have causes damage they could have prevented and could be challenged legally. There is a certain amount of institutional cover in not changing the way TWSA is calculated, so it can be argued that "we did what we always do," and this has buy-in as a procedure. "Soft" areas of management are more flexible and riper are for forecast use, since procedures are less fixed and the consequences are smaller to the customers.

- Getting TWSA accurate, early, and firm. The return flow and reservoir content components are relatively sure. April-September runoff is harder. Timing of the runoff is harder still (e.g. a "pineapple express" that removes snowpack in midwinter and early spring, through melting, rain-on-snow, or sublimation (in the mid 1980s, they had 500,000 ac-ft of water disappear one winter from the snowpack through sublimation—high pan evaporation was not taken into account). The tendency for this kind of phenomenon under different climate states could be investigated
- Forecasting fall rains is hard, but it drives the winter risk assessment for incubation flows. Both 1987 and 1992 had exceptionally long, dry fall weather. The tendency for this kind of phenomenon under different climate states could be investigated.
- Forecasting frozen soil conditions that lead to rapid winter runoff if warming occurs in midwinter. This happened in 1995-96. This is not so much a forecast issue as it is a monitoring issue (could have soil observations). Could look at risks of midwinter warm periods by climate state.

In-season daily water management at the local level could be improved with high-quality 10-15 day forecasts, since this would affect demand

8. Things the water managers wish the ultimate water users understood

- The ultimate customers (the farmers) need to know how little influence Bureau of Reclamation actually has. Only about 20% of annual flow actually goes into controlled storage over which BuRec has positive control. Even most in-season flow is from uncontrolled tributaries.
- The ultimate users also need to know that significant events like floods are also largely beyond the control of BuRec for two reasons: 1) storage flexibility is limited; and 2) most water in floods comes from sources below the dams or on uncontrolled tributaries.

Workshop 2: **Questions on Long-Range Climate Forecasting for Irrigators/ Water Users**

1. Do you use long-term weather forecasts in your work? If not, why not? If yes, how do you use them?

- Districts and farmers have no weather forecaster. One manager would pass through information to individual landowners to help them make management decisions. The district managers have too many constraints to operate independently.
- A farmer on another junior district said the district is pretty good about passing forecasts along. They have links to forecast websites. In addition, some landowners are probably paying for weather forecasters themselves.
- Water users (irrigation districts and farmers) are generally aware of long term weather forecasts, but they tend to rely on Bureau of Reclamation's early estimates of TWSA, which begin in January and are updated monthly (every two weeks in dry years).

2. Do you know about NOAA seasonal weather forecasts?

- They are aware of them

3 Do you use the NOAA seasonal forecasts in your work?

BuRec compares snow and reservoir fill as similar to some year "x" in as the example and look at pie chart. They separate out years based on their climate scenario, and give you a guesstimate for water supply. They track this and update on a monthly basis (2 week basis in a dry year).

4. What information do you use to determine whether we are experiencing drought?

5. Do you use forecasts of Total Water Supply Available? If not, why not? If so, how?

Prorationing comes in 10,000 ac ft blocks—roughly equivalent to 1% of flow. (Note: this is a good topic for graphic story-telling). Water supply forecasts need to predict at this level.

6. If NOAA could provide perfect weather forecasts for the coming water year, what difference would that make to any water management decisions that you make? Does it make any difference when the forecast is available? E.g., would you change anything if the perfect forecast were available in March? January? October?

Weather information is useful, but TWSA (the Bureau of Reclamation water forecast) is what counts.

7. What if perfect water availability forecasts were available? E.g., would you change any decision if the perfect water availability forecast were available in March? January? October?

> The sooner the better. Water information out in January? Districts wait to put out their newsletter until they have Bureau information—usually in April. Districts would get information to their customers right away, but would wait for TWSA before making info available. Information needs to be as good as possible as early as possible.

8. NOAA climate forecasts and BuRec TWSA forecasts are somewhat uncertain. How does this affect your use of the forecasts and why?

- Would rather have the forecast increase over time
- Counterexample: in 1979 "plenty" became "not enough"

Banks, processors, marketers all now look at availability of water and are concerned about the credibility of the water forecasts. BuRec is asked about the reliability factor and have an interest in being knowledgeable. Del Monte has become concerned enough to not do contracts for sweet corn in the Roza.

9. What is the single hardest thing to "get right" in your water management decisions? When do these decisions happen? What happens if you are wrong? Would a "better" weather or water forecast help? If so, what would such a "better forecast" look like and how would it make your decisions better?

> A key issue is whether there will be enough water to "run the canal." For 2001 the forecast was direr than the actuality. If they get 75% of full water entitlement, they will get a full crop. They have gotten better at managing water (also less fertilizer and pesticides) with new monitoring techniques. Sensors have become more affordable and user-friendly.
>
> Water trading is becoming more of a business decision, constrained by political considerations and the physical ability to move the water.
>
> Hops are going to drip irrigation, both for water during drought and for water quality considerations.
>
> One farmer mentioned the perfect forecast: The sooner the better. In 2004, bought. The farm in question bought $300 K worth of water based on concern over forecasted low water going into the season, but bought double the water they needed. They might be skeptical next time.
>
> One consultant said he would pass along early information to clientele as soon as possible. And noted that probably their irrigation monitoring service would become more important.

With early forecast of drought could get better price for replacement water. Everyone could make decisions earlier, so don't make investments that raise costs later (people who are going to lose their principal source of water).

With less perfect data, personal experience will influence their upcoming decision to buy replacement water early in the season.

Another consultant noted that if the forecasts were fuzzy, he would suggest buying water options—hedge bets and see what would happen with the forecasts.

Another use of forecasts is timing and scheduling maintenance. They have a small maintenance window when there is no water in the canal, but construction weather is reasonable. They believe that they could plan maintenance based on expected weather, e.g. total concrete replacement [in years where there wasn't expected to be much runoff].

What would a perfect forecast look like? This varies, but in KRD it is: in a short water year, what is the cutoff date for users, since they commit to as much water as early as possible and let late season crops suffer. Bureau of Reclamation continually recalculates TWSA (moving target). KRD would want to know how long they will be able to execute. (KRD has only 500 acres of corn, 300 acres of potatoes, so not much flexibility with row crops). Stock growers need to know about stock water availability. Roza cares more about the late season and is willing to give up water in the middle.

10. Currently, with a declaration of drought as in 2001, it is possible to temporarily transfer water. Have you ever considered participating in these trades as a seller? If it were possible to participate as an individual buyer, would you? How would you make your decision?

One junior district (Kittitas Reclamation District) bought a 5,000 ac ft of water in April 2004 because the forecast was 70% water available for junior users. Paid $11/ac ft. (Another district paid about $125 per ac. ft.). One developer gifted water as well (11,000 ac ft?)

In 2001, which was a dry year (although not an El Niño year) water was traded within the Kittitas Reclamation District, a junior district. 2/3 of traders were selling (small lots). Bigger outfits purchased because they had the flexibility to make better use of the water. The smaller guys cared just as much, but have more trouble being effective in accumulating and using purchased water.

KRD grows mostly Timothy hay, with a few acres of tree crops. For the most part, they are not competitive in purchasing water with the Roza, which grows apples, grapes and other high-value crops.

Roza Irrigation District, because of their cropping patterns in perennial crops, can't "play" economically on the selling side. They put in emergency drought wells to cope, and buy all of the water that they can.

Price of water for three acre feet is about $88. In a water short year, what growers are willing to pay is open-ended, essentially "anything" ($500 to $1000), since excess loss without water is about $10K to $25 K per acre. In 2001, Sunnyside Valley Irrigation District (SVID), a generally more senior water rights district, leased Roza open ground for less than $250. About 750 acres within the district bought water at up to $250/ ac ft. Shut down the main canal for 4 weeks at mid season because a certain minimum flow is needed to operate it (it works better with added check valves).

In 2001, Roza shut down the main canal for 4 weeks at mid season because a certain minimum flow is needed to operate it (it works better with added check valves)., and because water is needed early and late. Bigger acreage holders can juggle within their operations and can "stretch" water– can do "bunching" short water from field to field in cooperation with neighbors. And ditch riders will advise them and provide help in water management.

Note: More and more people are coming into the Roza who don't know anything about irrigation water

11. If climate forecasts for a coming water year indicated a high probability of drought, would you consider temporarily trading water as either a buyer or seller? What things would you consider?

One thing to consider is the value of the crop, and the difficulty of reestablishing the crop, once lost. For example, apples take longest to reestablish (4-5 years), then wine grapes, then asparagus or hops. If you could provide drought information, then the sooner the better

In a water short year (e.g. 2001) if they knew in January one farmer said they would have planted no corn, only wheat (which matures earlier). This would have shifted about $125,000 to their bottom line. They would take as much water as possible early, to still get water onto the crop at the critical time. Corn for grain: if late season is projected to be dry, need water by the first of June. If growing wheat, by June the water needs are tapering off. Spring wheat uses about 65% of the water that winter wheat does. In January, they could be banking water. Also, they wouldn't [plant later potatoes –plant in the early spring.

12. Do you think there are any barriers in the way of water trading in response to drought? What are they? Are there changes you think are possible?

The barriers are a little different in each district. Many of these have to do with physical constraint on actually moving traded water.

- It is important to note that, because of the need to meet obligations to its membership and control third-party impacts of water trades, irrigation districts generally require that the inter-district trades go through the district, and sometimes intra-district trades as well. No transfer is allowed to increase consumptive use (TWSA neutral)
- In Kennewick Irrigation District there is a major infrastructure problem. Some of the local improvement districts (LIDs) are old, and the members don't want to band together make system repairs. In 2001, KID rationed water by day (2-3 day rotation). But this did not always work. One farmer said he took water "when he could get it."
- In KRD, it depends on impact on actual system operation. Political constraints and system operational constraints really limit ability to transfer water out of KRD. During normal water years, KRD have restrictions on water transfers because it can only physically obtain water from two of the five reservoirs, and because it needs its water early in the season. Assess $43/acre in the lower district, 75% of that in the upper. No upper valley water to be transferred to lower valley. Can in extreme water short years. KRD would never be an outside-of-district seller in a short water year; might be a buyer to do a second cutting of Timothy hay (if they could get the water), but never for corn or wheat. But would need a lot of water to extend the season, and plumbing and BuRec policy limit that. Also, there isn't enough tributary water to buy. Could not buy water from further down the system for upper part of KRD, because can't pump from Yakima (Tieton, for example, or Cle Elum). And the physical water would have to come from Keechelus or Kachess (an addition of 40 ft to the top of Cle Elum Dam would change the constraint).

- In the Wapato Irrigation Project (WIP), a very large and senior district, the physical infrastructure (e.g. the laterals and check structures) is in bad shape because of years of deferred maintenance. Farmers can't sell water rights. There is some question whether the water rights mean anything, since the system can't deliver the water reliably. Only the Wapato Irrigation Project as a whole (BIA trust) has water rights. There is a water right in the Wapato Irrigation District (WID). The WIP entitlement is 3000 cfs, which they are unable to take or use (only take about 2200 cfs). There are no investment $ available for physical infrastructure development. A lot of acres have not paid their water bills (assessments) and can't raise the assessments on tribal land. Debt to federal govt has been written off. Interestingly, one farmer guessed that WIP probably would not transfer water out of district, since they might have trouble running the laterals.

Other barriers include:

- For Black Rock concept of moving water from the Columbia to the Yakima, concept, commingling of Yakima and Columbia waters is an environmental issue (salmon false attraction), even if the water were available.

- Groundwater: How does it fit with surface water? Proratable wells –are they increasing consumptive use-or not?

- Groundwater Adjudication –is water available to the district? Or is it project water?

- Groundwater relationship to irrigation and surface water. Can a district pump water into ground and then take out for beneficial later since put into ground? (Also, there are water quality issues with this approach.)

Work Shop 3: <u>Questions on Climate Forecasting and Climate Change for Water Managers/Irrigators/Water Users</u>

1. It has been projected that climate change (warming) would reduce winter snowpack in the Pacific Northwest, with a higher proportion of annual precipitation falling as winter rain and feeding winter (rather than spring) runoff. As a result, it is likely that a greater proportion of water years would have low Total Water Supply Available (TWSA). However, it is likely that climate change (as distinct from climate variability) would only become evident over a number of years. Existing water institutional decisions and frameworks are based on current climate and water availability. Do you think that there any improvements that could be made to the current operating regime that would also improve the response of the system to climate change?

- A water bank, which is being set up, would need some advance notice in order to work in any given year.
- They have done the calculations on consumptive use and the so-called “box” for approvals by consensus. Conservation Advisory Group set up under the 1994 Yakima Basin Enhancement Act was working on such a concept when the 2001 drought showed up, and they adapted it.
- Although it hasn’t quite been done, they think it’s possible to identify in advance what kinds of trades could be allowed by basin, subbasin, and project, including (if BuRec cooperated) BuRec’s ability to manage the transfer. (See roundtableassociates.com website). The are working on a permanent
- It takes more than one big drought to finalize institutional arrangements. 1994 started the institutional setup after the basin water interests argued all summer. 2001 tested it the methods in an actual drought. This summer, if it is as dry as it now appears it will be, may give the final push to make a water bank happen?
- There are physical structural (“plumbing”) problems with trading. KRD, for example, can get water only from Keechelus and Kachess. So whatever water rights they get it via trading has to be delivered from that source, which is drained relatively early in the year. (Also, there was an upper limit of 25,000 ac. ft. that BuRec could facilitate in 2001, due to water source mismatches.) A

pump below Cle Elum reservoir would allow cross transfer to KRD that could make the current system work better as well as provide for future flexibility. A pipeline between Keechelus and Kachess would also help fill the latter reservoir.

- More carryover would be helpful to both the current system and with climate change. But irrigators currently can't get credit for leaving water in storage in one year, because of uncertainty of winter flooding, which means that reservoirs have to be evacuated in the fall to make room for winter runoff. And 51% of the BuRec budget comes from the Corps, who wants zero damage from floods. So have to run down the reservoirs for dam safety and flood. A context-sensitive rule curve would help here. The unexpected usually happens—in 1996, they had to dump a lot of water in March and April, and were very close to a flood that could have been 50% larger.
- One thing that improve the current system and would prove useful in future as climate as well is to "flood the floodplain," i.e., try to bring the river back to its more natural state by moving the dykes back from the river and not developing right up to the water's edge. This would give BuRec much more flexibility in allowing higher winter flows when necessary under current climate and would be even more valuable when low elevation snow melts earlier in the year under climate change. BuRec and the Yakama Indian Nation are trying to do this by acquiring floodplain land. However, much of this land is now the site of industry, and is expensive to acquire. FEMA was putting in tighter restrictions for flood insurance, but has now reversed course.
- Local governments like the economic development that comes with development of these areas. They are also concerned about "taking" people's property which can be sold to industry) without compensation. Counterexample: Suncadia (Formerly Trendwest resort) was going to build in Cle Elum River Flood plain. They got talked out of it., and got credit for greenbelt and conservation.
- Wymer project storage and tunnel. A dam near the mouth of Lmuma Creek could create an off-channel reservoir which could store about 142,000 acre-feet of water. During high flow periods, water would be pumped from the Yakima River by a pump station above the Roza diversion dam and would be stored in Wymer Reservoir. Stored water would be released for irrigation and instream flow purposes. .
- Other storage
- In the Toppenish area, there is 125,000 ac ft in ground water missing from groundwater control. Irrigation infiltrates, and adds that much to the groundwater level, after which it stabilizes and return flow is pretty constant. If done right, could use natural flow early in the spring to fill up the groundwater, so didn't have to use storage water to do it. (Would need an infiltration gallery, which the Wapato Irrigation Project would not be able to afford.)
- Generally, improving the efficiency of the system helps now and would help under climate change. Investments in piping, canal lining, and drip irrigation. Can reduce the need for withdrawals. But conveyance losses may largely

make it back to the river as return flow. KRD should be flooded early, and dripped late to take advantage of the one-month lag in return flow to the lower river.
- Aquifer storage and recovery is being tried by the city of Yakima and might be tried elsewhere

2. If climate change really changes the availability of water in the Yakima basin in the next few years, who would be most fundamentally affected? If availability of water changes, are there fundamental changes that might have to be made in the way water managers, water users, and regulators operate? What standard of proof for "changed of availability of water" should be used to make these changes? What kind of analyses and information concerning consequences of climate change would be needed to determine what changes to make?

- Junior water users, until they are reduced to zero.
- KRD would become a 1-3 acre ranchettes with exempt wells (1/2 acre irrigated, well yields up to 5000 gal/day, require no permits)—no production agriculture. This is already happening to some extent. KRD would be trying to recover debt retirement costs from a large number of "customers" to whom they may well be unable to deliver water.
- Some crops might be benefited—at 2 degrees C, KRD would become feasible for peppermint. But would have to do it in one bank account year (crop switch).
- Growers of Timothy hay with tributary water rights might be able to get one cutting without KRD water.
- Production agriculture might be abandoned in some areas: In Pine Hollow (Ahtanum District) when water became less available, permanent crops like hops and late corn are no longer being grown. Less acreage overall. What's there is alfalfa, pasture, barley. South of the river, where they have some well permits, apples.
- Fish—they are making progress, and would probably get a protected share of the water. In 1977, they stopped the flow below Sunnyside entirely. In 1994, they argued about taking the fishes' water. In 2001 they accepted instream flow as a constraint. 300 cfs is much smaller than any of the districts diverts.

Types of analysis and information
- KRD, if it had BuRec forecast earlier in the year would do more landowner education. More would be needed than just education for severe prorationing. Tools to do conservation would be needed (e.g. getting from 60% water up to 70% + can be done with education, but But 30% prorationing is more than one-season enlightening can do. KRD would probably work with other districts and water purveyors.
- Attention being given to TMDL and ESA considerations would give way to saving the crops
- Knowledge 10 weeks rather than 10 years in advance—you could facilitate dry year options, such as leasing.

- It would be helpful to know in January/February before investing occurred in a given crop year.

3. What are the best options for creating “additional” usable water supply in the Yakima Valley? Why do you think so? What are the major barriers to securing additional water? What kind of information would reduce those barriers? Would any of the options or barriers change if water became less available? More available?

- Respondents resisted the idea of “creating” additional supply, and argued that all they can do is manage better what supply there is.
- There was some discussion of the $1.8 billion, 1.7 million acre-foot Black Rock reservoir concept, which imports water from the Columbia River into the lower Yakima basin. While they were intrigued by the possibility that importing water looks more beneficial under climate change (because it more frequently offsets the need to proration junior water users than under current climate), they also were concerned about whether water would be available from the Columbia under a changed climate.
- There was also discussion of smaller storage projects such as Wymer, Cle Elum.

4. Currently, the chances of serious prorationing of water in the Yakima are about one year in seven (about one in three during El Niño years). How much do you think the odds of prorationing would have to change to significantly affect the mix of crops in the valley or the farming methods? If the water supply really changes, how should entitlements be treated? What about instream flow?

- We never got a quantitative answer to the first part of this question. They would respond to information such as demonstrated changes in runoff patterns or demonstrated earlier onset of storage control (spring freshet becomes winter flow)..
- They do not think that entitlements would change, even if water became demonstrably scarcer, since it would be too difficult for the courts to undo all of the case law to date. Entitlements are currently managed under the 1945 consent decree and are not perfected.

5. Water exchanges are currently allowed in the Yakima basin on a limited basis. What are the most significant institutional barriers to water exchanges as a means to mitigate the effects of periodic drought? How broad do you think the authority to trade water should be? Individuals? Irrigation districts? A central exchange (“water bank”)? What limits and controls are necessary? Should water trades be confined to periods of drought? Should trades be only temporary, or should permanent trades be allowed? What do you see as the advantages and disadvantages of these methods?

- The somewhat ad hoc water exchange system in the Yakima Valley is migrating toward a centralized permanent water bank structure, with third-party effects calculated in advance, and blanket criteria given on what acceptable water trades would be.

6. Are there changes to law and regulation that you think are necessary to support a fully functioning system of water exchange that might also work for climate change?

- No explicit changes were described. We were referred to some of the history, captured in the website of the firm that facilitated much of the discussion (roundtableassociates.com).